Modeling of quantum capacitance in graphene nanoribbon

Abstract:

The capacitance in the classical approach is completely determined by the device geometry and a dielectric constant of the medium. However, the quantum effects will give significant impact on the device performance once the transistor approaches the size of nanoscale device and hence the quantum capacitance must be taken into consideration. Considering the consequences of quantum capacitance on the device performance, we decided to work towards the analytical modeling of quantum capacitance in degenerate and nondegenerate regime for Graphene Nanoribbons (GNRs). The effects of classical capacitance in nondegenerate regime and quantum capacitance in degenerate regime are discussed. We showed that in low gate voltage, Vg total capacitance is equivalent to the classical capacitance but in high gate voltage range, the total capacitance is equivalent to quantum capacitance or in other words in nondegenerate regime, total capacitance was equivalent to the classical capacitance and that the quantum capacitance can be neglected. However, we suggested that only quantum capacitance is taken into account in the calculation of total capacitance in degenerate regime.